(12) UK Patent Application (19) GB (11) 2 137 783A

(43) Application published 10 Oct 1984

(21) Application No 8405832

(22) Date of filing 6 Mar 1984

(30) Priority data

(31) 58/038196 (32) 10 Mar 1983 (33) JP
58/244210 26 Dec 1983

(51) INT CL³
G06F 3/00

(52) Domestic classification
G4A 5A 5X KB
G3T 101 301 407 AAA
U1S 2199 G4A

(56) Documents cited
US 4276541

(58) Field of search
G3T
G4A

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(54) Electronic Equipment with Touch Switches

(57) Electronic equipment with touch switches (12) exchanges data between an internal memory (33) thereof and an external device (28) by means of the touch switches (12) which are mounted on the case of the equipment, and by means of a modem (2) which adopts the tone burst system and which utilizes a contact capacitance component between the touch switches and conductive rubber contacts on the modem.

FIG. 4

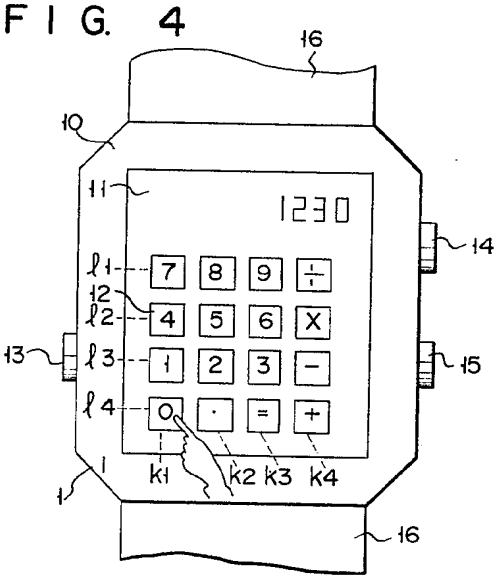
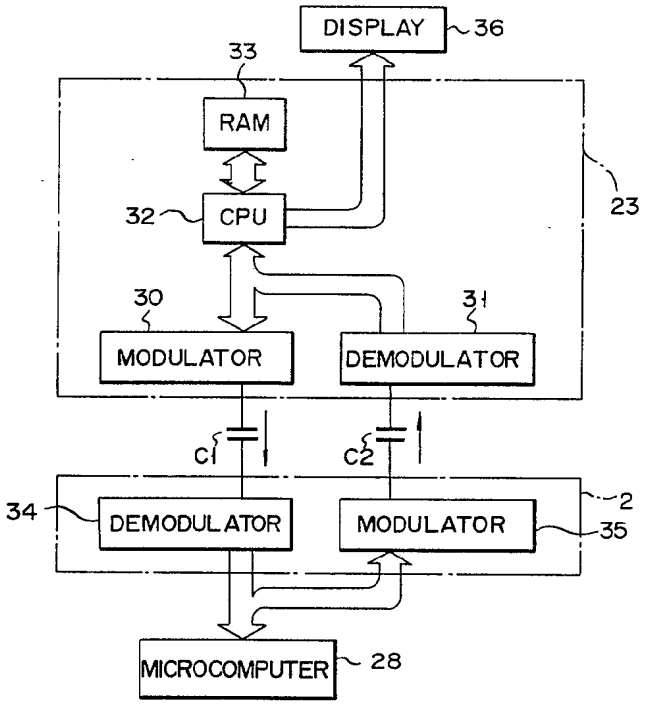


FIG. 9



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The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

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FIG. 1

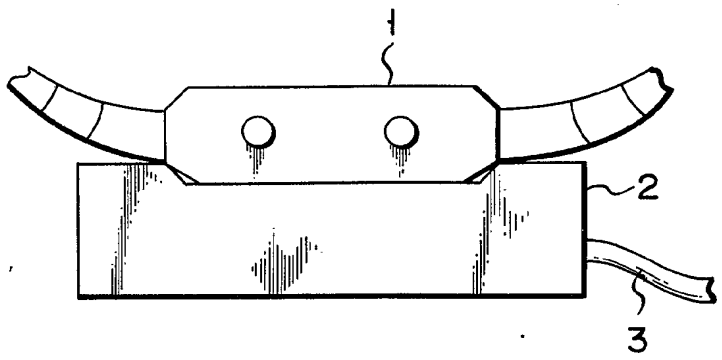

FIG. 2

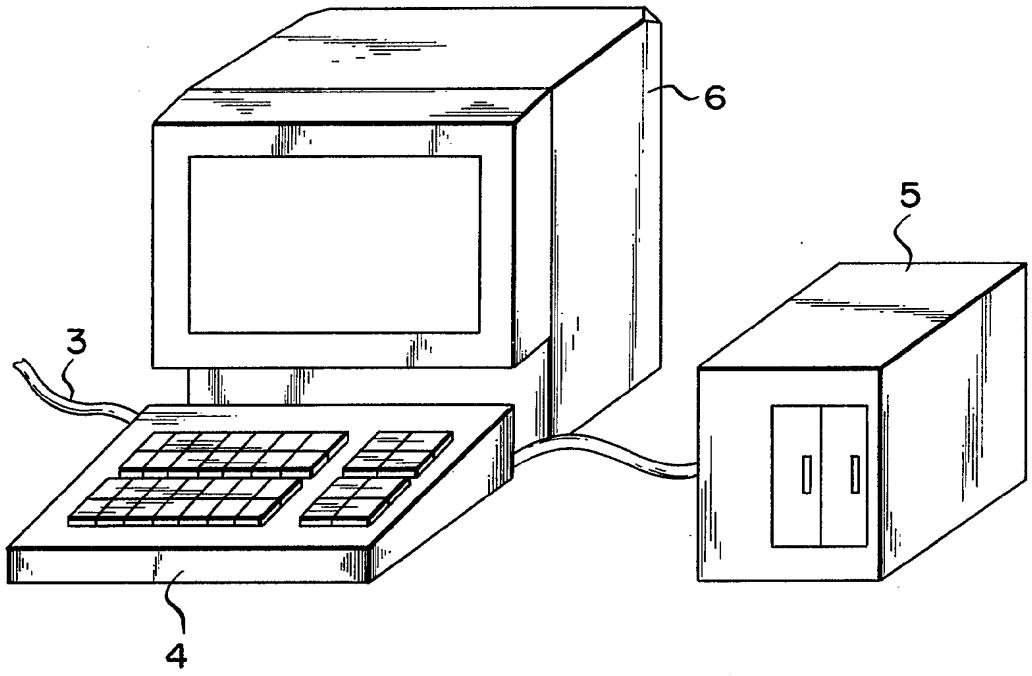

FIG. 3

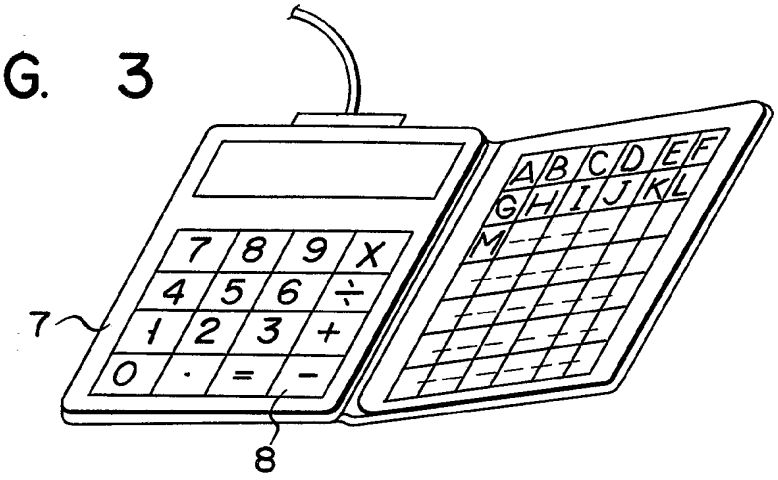
A B C D E F
G H I J K L
M
7 8 9 X
4 5 6 ÷
1 2 3 +
0 · = −
7
8

FIG. 4

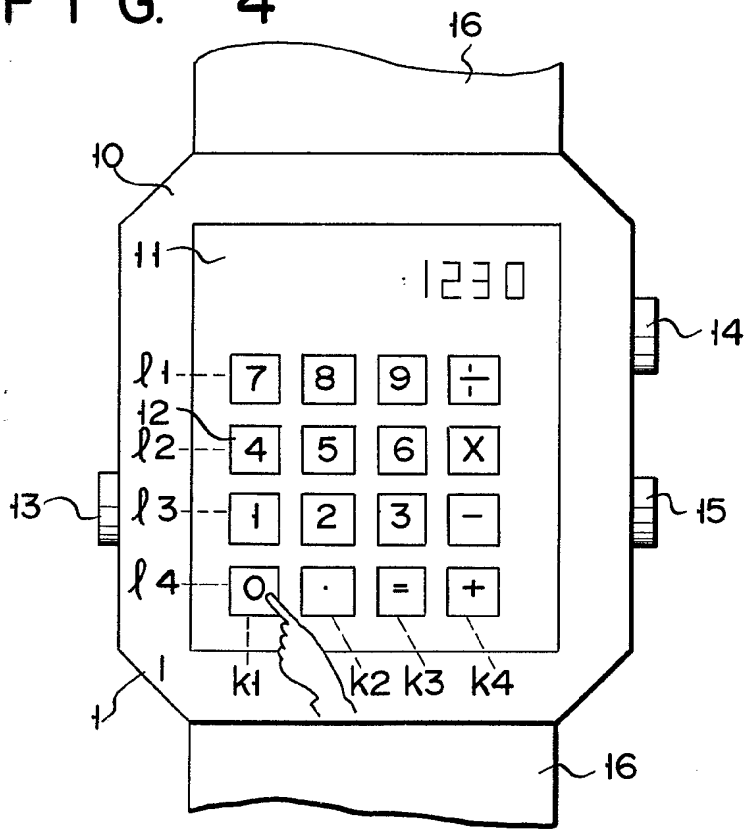
16
10
11
1230
14
ℓ1
7 8 9 ÷
12
ℓ2
4 5 6 X
13
ℓ3
1 2 3 −
15
ℓ4
0 · = +
k1 k2 k3 k4
1
16

FIG. 5

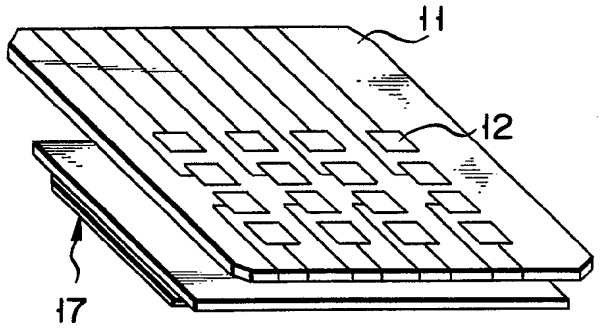

FIG. 6

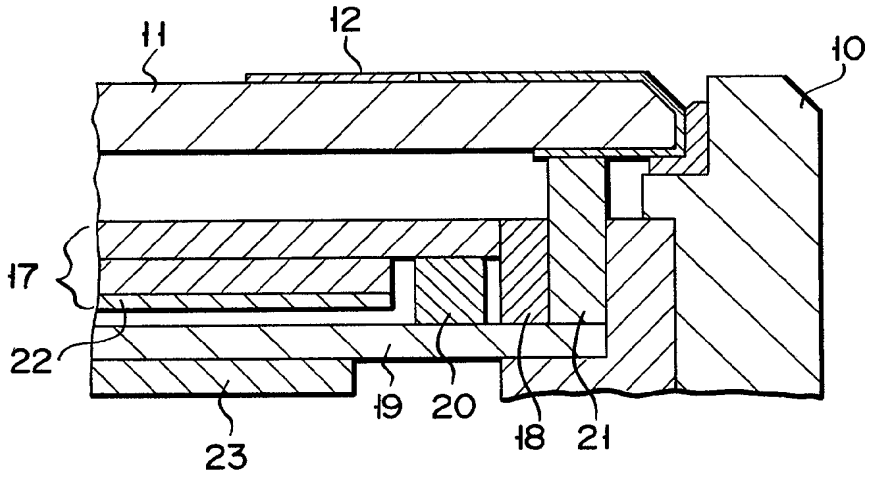

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FIG. 7

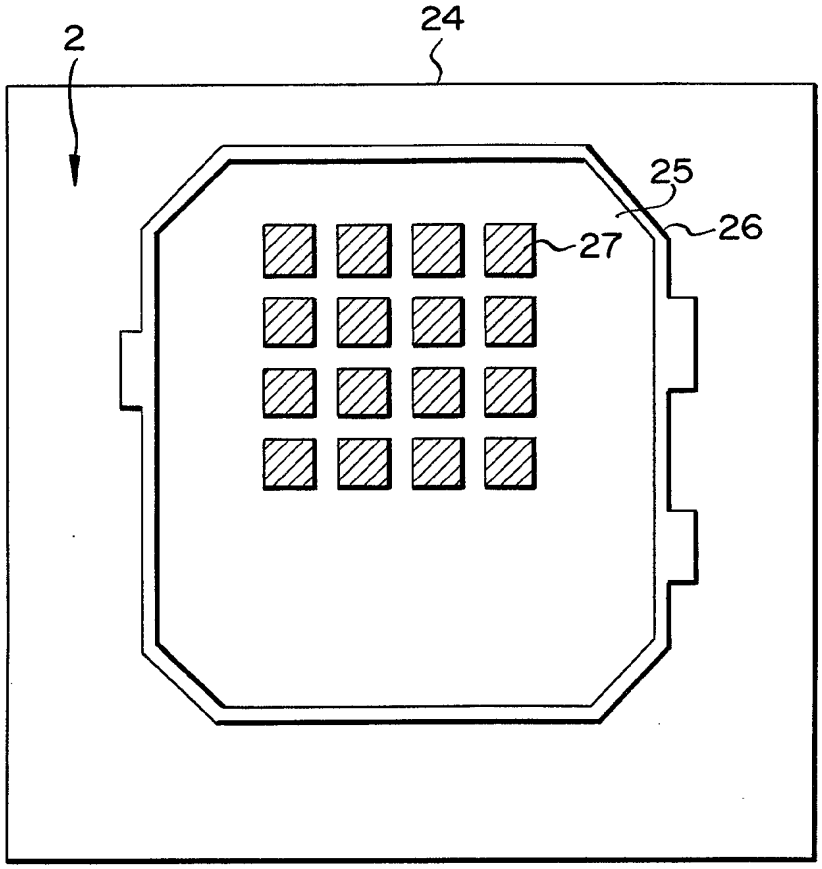

FIG. 8

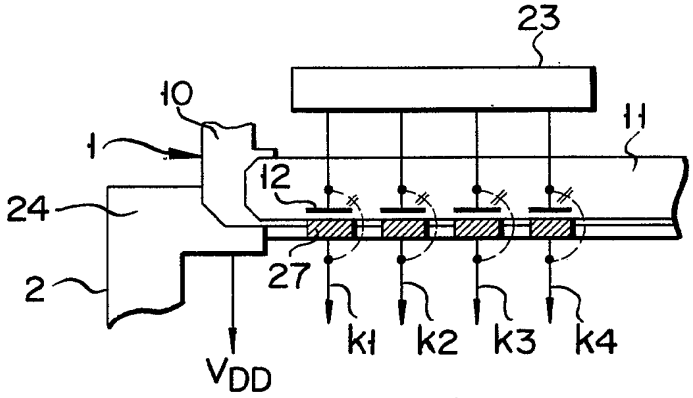

FIG. 9

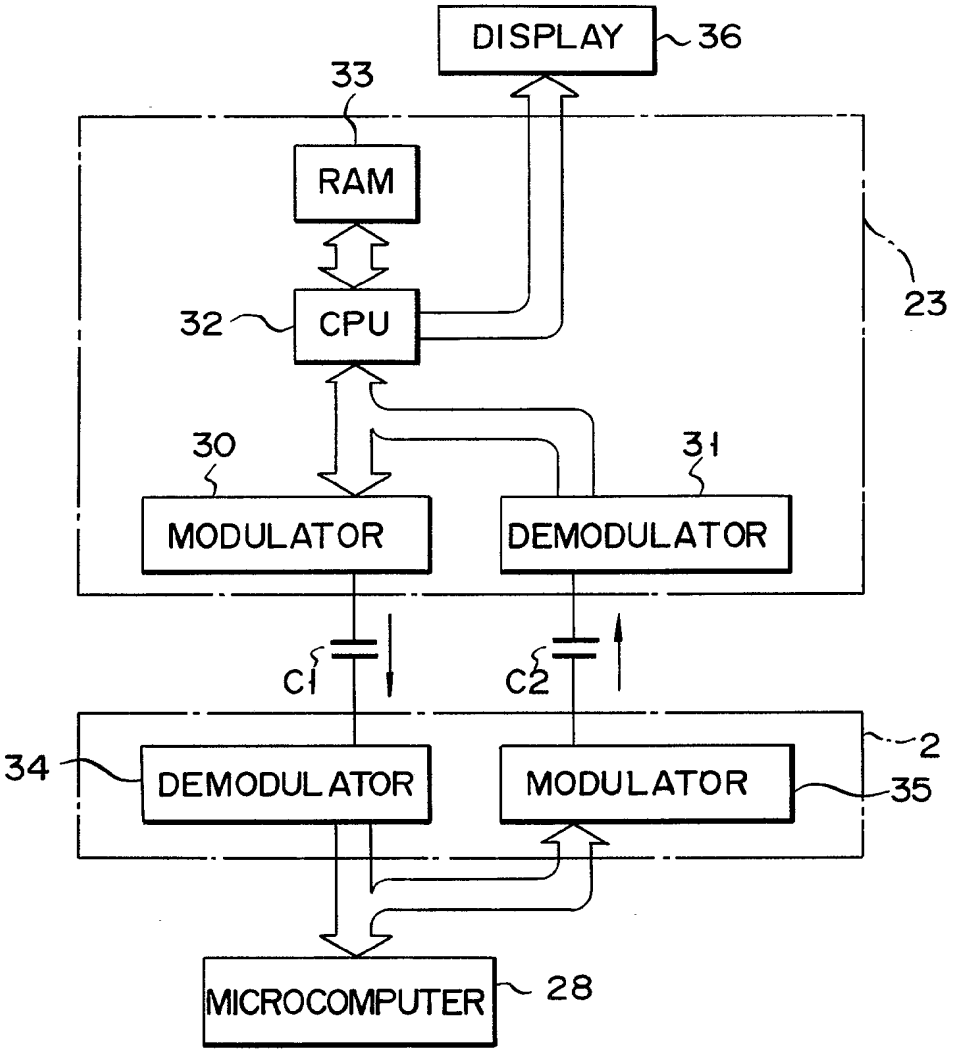
DISPLAY
36
33
RAM
32
CPU
23
30
31
MODULATOR
DEMODULATOR
C1
C2
34
DEMODULATOR
MODULATOR
2
35
MICROCOMPUTER
28

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FIG. 10

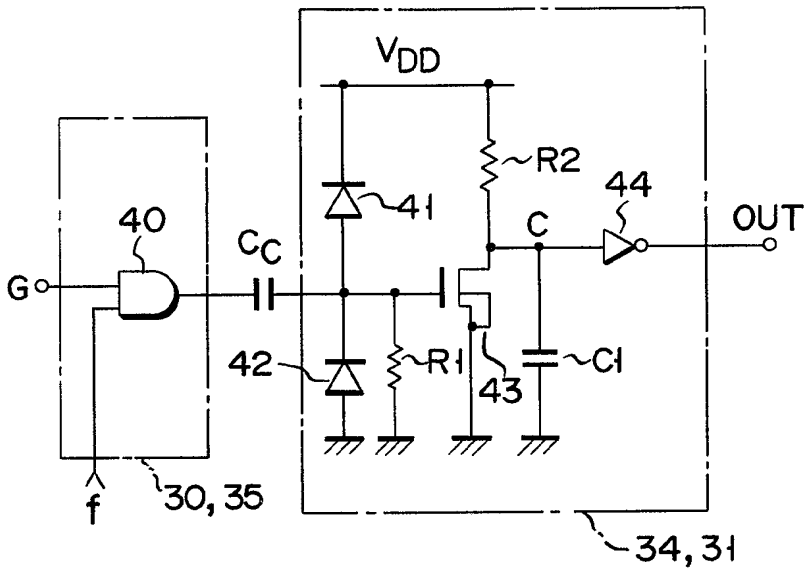
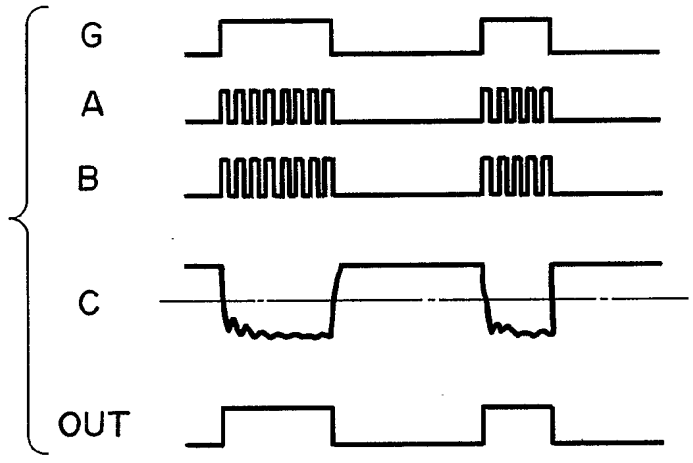


FIG. 11



SPECIFICATION

Electronic Equipment with Touch Switches

The present invention relates to electronic equipment which has a plurality of touch switches mounted on a main body, which contains a memory and which exchanges data with an external device.

With the rapid developments in the LSI technique, an ROM (read-only memory) or a RAM (random-access memory) of a large capacity is frequently assembled in electronic equipment such as electronic wrist watches, word processors or electronic calculators. Such equipment with a ROM or RAM can perform their original function as well as the additional function of displaying memo data preset in the ROM or RAM as needed. Data is exchanged between the RAM in the electronic equipment and the external device either by mechanical or nonmechanical coupling. Data exchanged by mechanical coupling is disclosed, for example, in U.S. Patent No. 4,165,605 wherein terminals of the electronic equipment and the external devices are connected to each other. Data exchanged by nonmechanical coupling can be achieved by magnetic coupling as disclosed, for example, in U.S. Patent No. 4,023,344.

However, in the former case, when for example, the electronic equipment is an electronic wrist watch which is mechanically coupled to a reference clock device for time correction, the rear cover of the wrist watch must be able to open to allow access to the terminal. The terminal of the wrist watch can then be connected to the terminal of the external device. This is a complex operation and presents the problem of poor waterproofing since the watch's rear cover must be opened each time access to the terminal is made.

On the other hand, in the latter case, as in U.S. Patent No. 4,023,344, magnetic or optical data exchange requires the use of a magnetic or optical sensor, resulting in a bulky apparatus.

It is an object of the present invention to provide electronic equipment with touch switches capable of data exchanging data easily with an external device by means of touch switches and which uses mechanical coupling.

In order to achieve the above object of the present invention, there is provided electronic equipment with touch switches for exchanging data with an external device, comprising:

(a) a case of said electronic equipment;

(b) an electronic circuit which is arranged inside said case which has at least one memory circuit and a control circuit for controlling said memory circuit;

(c) touch switch means arranged on the outer surface of said case which is electrically coupled to said electronic circuit, said touch switch means serving as the input switches for controlling said electronic circuit when it is in contact with a human body, and in which the positions of said switches correspond to the positions of the connecting terminals for exchanging data with said external device; and

(d) a writing means for supplying data in said memory circuit to said touch switch means in order to write the data from said touch switch means in said memory circuit so as to exchange the data with said external device.

The electronic equipment with touch switches having the above configuration exchanges data between the memory of the electronic equipment and the external device by means of the touch switches arranged on the main body and by means of a modem which adopts the tone burst system and which utilizes a contact capacitance component with the external device. The electronic equipment of the present invention can thus allow manual data to be input by means of touch switches while assuring that data is exchanged by the mechanical coupling.

This invention can be more fully understood from the following detailed description when taken in conjunction with the accompanying drawings, in which:

Figure 1 is a view of an electronic wrist watch as an example of electronic equipment according to the present invention in the state wherein the watch is mechanically coupled to a modem;

Figure 2 is a schematic perspective view wherein the external device of the present invention is applied to a word processor;

Figure 3 is a schematic perspective view wherein the external device of the present invention is applied to an electronic calculator;

Figure 4 is a plan view of an electronic wrist watch according to another embodiment of the present invention;

Figure 5 is a perspective view showing the configuration of a glass case with touch electrodes, and the liquid crystal display of the electronic wrist watch shown in Figure 4;

Figure 6 is a cross-sectional view of the main part of the electronic wrist watch shown in Figure 4;

Figure 7 is a plan view of the modem used in the embodiment of the present invention;

Figure 8 is a diagram showing the electrical connection between the electronic wrist watch and the modem;

Figure 9 is a block diagram showing the circuit configuration according to the embodiment of the present invention;

Figure 10 is a circuit diagram of a modem which uses the tone burst system according to the embodiment of the present invention; and

Figure 11 is a timing chart showing the waveforms of the respective parts of the circuit shown in Figure 10.

The preferred embodiment of the present invention will now be described with reference to the accompanying drawings.

Figure 1 shows an electronic wrist watch as an embodiment of electronic equipment according to the present invention. In the state shown in Figure 1, an electronic wrist watch 1 is connected to a modem (modulator/demodulator) 2 which in turn

is connected to the touch switches of the watch 1. The modem 2 is connected to an external device such as a microcomputer through a cable 3 so as to allow data to be exchanged between the watch 1 and the microcomputer.

Figure 2 shows a case wherein an external device is a word processor which consists of a key input device 4, a floppy disk device 5, and a CRT device 6. The key input device 4 is connected to the modem 2 so as to allow data to be exchanged between the electronic wrist watch and an external device.

Figure 3 shows an electronic calculator 7 as the external device of the present invention. The electronic calculator 7 is connected to the modem 2 so as to allow data to be exchanged between the memory of the electronic calculator 7 and the electronic wrist watch 1.

Electronic equipment with touch switches according to the present invention has a built-in memory. It can exchange data with an external when it is connected to the external device by a modem.

An embodiment wherein an electronic wrist watch is the electronic equipment of the present invention will now be described with reference to Figures 4 to 11.

An electronic wrist watch 1 shown in Figure 4 has a cover glass 11 on the upper surface of a case 10, and a rear cover (not shown) on the lower surface. 16 transparent touch switches 12, including ten keys and function keys, are arranged on the cover glass 11. Three separate switches 13, 14 and 15 and a wrist band 16 are arranged at the ends of the case 10.

Figure 5 shows the positional relationship between the cover glass 11 of the wrist watch 1 on which the touch switches 12 are mounted, and a liquid crystal display 17 arranged below the cover glass 11. Figure 6 is a cross-sectional view of the wrist watch 1.

A circuit board 19 is fixed by a housing 18 in the case 10. A conductive interconnector 20 electrically connects the liquid crystal display 17 and the circuit board 19. Another conductive interconnector 21 electrically connects the circuit board 19 and the cover glass 11 with the touch switches 12 thereon. A reflecting plate 22 is arranged at one side of the liquid crystal display 17 which is separated from the circuit board 19. The other side of the liquid crystal display 17 is also separated from the cover glass 11. An LSI chip 23 is mounted on the rear surface of the circuit board 19 and is electrically connected to the liquid crystal device 17 and the touch switches 12.

In the electronic wrist watch 1, as shown in Figure 4, numbers (0 to 9), function symbols (+, −, ×, ÷, and =), the decimal point and the like are displayed by the liquid crystal device 17 at the positions respectively corresponding to the touch switches 12. Thus, the liquid crystal device 17 clearly indicates the positions of the transparent touch switches 12. When a touch switch or switches 12 are operated, the corresponding input is supplied to the LSI chip 23 through the conductive interconnector 21. The entry data, the calculation result and the like is displayed above the liquid crystal device 17. Since control of the electronic circuit by means of touch switches is well known, the detailed circuit configuration for this purpose will not be described.

The modem 2 has the configuration as shown in Figure 7. A recess 25 is formed in the upper surface of the case's main body 24 of the modem 2. The recess 25 is slightly larger than the cover glass 11 of the electronic wrist watch 1. When the electronic wrist watch 1 is received in the recess 25, the watch 1 is positioned by a frame 26. Sixteen conductive rubber members 27 are arranged at those positions of the recess 25 which correspond to the respective touch switches 12 of the electronic wrist watch 1. A modulator and demodulator of the modem 2 (to be described later) are connected to these conductive rubber members 27.

When the electronic wrist watch 1 is received in the recess 25 of the modem 2 and the sixteen touch switches 12 contact the sixteen conductive rubber members 27, a contact capacitance component is generated. Data is exchanged through the modulator or demodulator utilizing this contact capacitance component.

Figure 8 shows the electrical connection between the electronic wrist watch 1 and the modem 2. The contact capacitance component is indicated by a capacitor symbol. A high voltage VDD is applied to the case's main body 24 of the modem 2, and a low voltage is applied to the touch switches 12. The touch switches 12 which are arranged in a 4×4 matrix are connected to a microcomputer 28 as an external device through signal lines k1 to k4 for each column of the matrix.

The circuit including the LSI chip 23 assembled in the electronic wrist watch 1 and the modem 2, and the connection between the circuit and the microcomputer 28 as the external device will now be described with reference to Figure 9. (In Figure 9, the circuit for initiating calculation upon depressing the touch switches is not shown).

A modulator 30 and a demodulator 31 inside the LSI chip 23 together constitute a modem in the electronic wrist watch 1. Data read out from a RAM (random-access memory) 33 is supplied to the modulator 30 through a CPU (central processing unit) 32. The modulator 30 converts the input data (8-bit parallel data) into analog serial data and supplies it to, for example, a total of 8 touch switches 12 in the first row l1 and the second row l2 as shown in Figure 4. In this case, the first through fourth bits of the 8-bit parallel data are respectively supplied to the touch switches 12 of the first column k1, second column k2, third column k3 and fourth column k4, of the first row l1. The fifth through eighth bits of the 8-bit parallel data are respectively supplied to the touch switches 12 of the first column k1, second column k2, third column k3 and fourth column k4, of the second row l2. The signals

supplied to these eight touch switches 12 are supplied to a modulator 34 of the modem 2 through a contact capacitance component Cc (Figure 10) which is formed between these touch switches 12 and the corresponding eight conductive rubber members 27 of the modem 2 at the side of the microcomputer 28. The demodulator 34 converts the input signals into corresponding 8-bit digital parallel data and supplies it to the microcomputer 28 through the cable 3.

The demodulator 31 of the LSI chip 23 is connected to the CPU 32 as shown in the drawings. The demodulator 31 receives the 8-bit parallel data from the microcomputer 28 through the cable 3, a modulator 35 of the modem 2, and the contact capacitance Cc (Figure 10) which is generated between the eight conductive rubber members 27 on the modem 2 and the corresponding eight touch switches 12 on the cover glass 11. In other words, the modulator 35 serves to convert the 8-bit parallel data from the microcomputer 28 into analog serial data. More specifically, the conversion signals from the modulator 35 which correspond to the first through fourth bits of the 8-bit parallel data from the microcomputer 28 are supplied to those conductive rubber members 27 which correspond to the touch switches 12 of the first column k1, second column k2, third column k3 and fourth column k4, respectively, of the third row l3. Conversion signals from the modulator 35 which correspond to the fifth through eighth bits of the 8-bit parallel data are supplied to those conductive rubber members 27 which correspond to the touch switches 12 of the first column k1, second column k2, third column k3 and fourth column k4, respectively, of the fourth row l4. As a result, the serial data input to the demodulator 31 through the contact capacitance component Cc of the eight touch switches 12 of the third and fourth rows and the corresponding eight conductive rubber members 27 is converted into 8-bit parallel data. The 8-bit parallel data from the demodulator 31 is written in the RAM 33 through the CPU 32.

The CPU 32 is a microprocessing circuit for controlling the clock function, the calculation function, and the like, of the electronic wrist watch 1. The CPU 32 also controls the read and write operation of data output and input into the RAM 33. A display 36 is connected to the CPU 32 and is controlled thereby. The display 36 comprises a liquid crystal display. It displays the time data and calculation result data stored in the RAM 33 and various data supplied from the microcomputer 28. The modulator 30 and 35, and the demodulators 31 and 34 have the configurations as shown in Figure 10. Each modulator/demodulator pair is connected through the contact capacitance component Cc according to the tone burst system. More specifically, the modulator 30 or 34 comprises an AND circuit 40 with a gate which receives a signal G (Figure 11) to be transmitted and a square wave signal f.

Meanwhile, the demodulator 31 or 34 comprise a series circuit of diodes 41 and 42 for limiting the amplitude of the power supply voltage. The output terminal of the AND gate 40 of the corresponding modulator 30 or 35 is connected to the node between the diodes 41 and 42 through the contact capacitance component Cc. The aforementioned node is connected to the gate of an n-MOSFET 43 and is also grounded through a resistor R1. The source of the n-MOSFET 43 is grounded, and the drain thereof receives a voltage VDD through a resistor R2. The cathode of the diode 41 also receives the voltage VDD. The node of the drain of the n-MOSFET 43 and the resistor R2 is connected to an inverter 44 and is also grounded through a capacitor C1. In the modulator 30 or 35, the square wave signal f supplied to one input terminal of the AND circuit 40 is switched by the signal G, causing it to be transmitted and produced as a tone burst signal A.

The tone burst signal A is supplied to the demodulator 34 or 31 through the contact capacitance component Cc whose amplitude is limited by the diodes 41 and 42 to become a signal B (Figure 11) which is supplied to the gate of the n-MOSFET 43 to turn it on or off. At this time, at the drain of the n-MOSFET 43, wave detection is performed and determined by the time constant of the capacitor C1 and the resistor R2. A signal C having the waveform shown in the drawing is supplied to the inverter 44 and is then sliced. The inverter 44 produces a signal which corresponds to the waveform of the input signal G, and which is obtained by inverting the signal C. The actual mode of exchanging data using the modulators/demodulators of a configuration having the tone burst system as described above will now be described with reference to the case of data exchanged between an electronic wrist watch as the electronic equipment, and a microcomputer as the external device.

Assume that memory data is to be written in the RAM 33 of the electronic wrist watch 1 from the microcomputer 28. First, the electronic wrist watch 1 is fitted in the recess 25 of the case main body 24 of the modem 2, with the upper surface of the watch 1 facing the bottom surface of the recess 25. Thus, the sixteen touch switches 12 on the case 10 respectively contact the corresponding sixteen conductive rubber members 27 on the modem 2.

The power of the modem 2 is turned on. Power is constantly supplied from a cell to the electronic wrist watch 1. Power is also supplied to the microcomputer 28. Data is input by operating the keys of the microcomputer 28. In this case, write data is produced from the microcomputer 28 in the form of 8-bit parallel data and is supplied to the modulator 35 of the modem 2 through the cable 3. The modulator 35 converts the input data into analog serial data and supplies the data to a total of eight conductive rubber members 27 which correspond to the touch switches 12 of the first to fourth columns k1 to k4 of the third and

fourth rows I3 and I4. Accordingly, since a contact capacitance component Cc is formed between each of these eight conductive rubber members 27 and the corresponding touch switch 12 on the cover glass 11, the applied data is supplied to the demodulator 31 in the electronic wrist watch 1 through the corresponding contact capacitance component Cc. The data is thus converted into 8-bit parallel data and is supplied to and written in the RAM 33 through the CPU 32. In this manner, the data supplied from the microcomputer 28 is sequentially written in the RAM 33.

The user of the electronic wrist watch 1 can cause the display 17 to display data stored in the RAM 33 such as names, addresses, and telephone numbers, and so on. In order to perform this display, the switches 13, 14 and 15 of the watch 1 are operated.

Assume now that many items of data in the RAM 33 of the LSI chip 23 (e.g., the addresses and telephone numbers of peoples) are to be supplied to the microcomputer 28 in the alphabetical order. In this case, a predetermined keying operation of the microcomputer 28 is performed to instruct readout of data from the RAM 33. Then, 8-bit parallel data is read out from the RAM 33 and supplied to the modulator 30 through the CPU 32. The modulator 30 converts the input 8-bit parallel data into analog serial data, and supplies this serial data to a total of eight touch switches 12 of the first to fourth columns k1 to k4 of the first and second rows I1 and I2. Thus, a contact capacitance component Cc is formed between each of the eight touch switches 12 and the corresponding conductive rubber member 27. The applied data is supplied to the demodulator 34 of the modem 2 through the respective contact capacitance components Cc. The demodulator 34 converts the input serial data into 8-bit parallel data which is supplied to the microcomputer 28 through the cable 3 to be processed therein.

When the user of the watch 1 wants to store another name, address and telephone number in the RAM 33, he enters this data in the microcomputer. Then, the current contents of the RAM 33 are supplied to the microcomputer which rearranges the contents including the new input data in alphabetical order. This reedited data is rewritten in the RAM 33 of the watch 1. When the switches 13, 14 and 15 are operated, the new data including the name, address, telephone number and so on can be displayed by the display 36.

In the above embodiment, the data including the names, addresses and telephone numbers is exchanged. However, the data to be exchanged is not limited to such data. For example, data such as schedule data or memo data can be exchanged. If the user of the watch is a salesperson, data about clients or other sales data can be written and later entered into the microcomputer. In this case, the circuit arrangement for supplying data from the microcomputer to the wrist watch can be omitted.

In the embodiment described above, the touch switches 12 are arranged in a 4×4 matrix. However, the number of touch switches can be changed as needed. Furthermore, the data to be exchanged need not be 8-bit data but may be, for example, 4-bit data. Although the present invention is applied to an electronic wrist watch, it can be similarly applied to other types of electronic equipment with touch switches. The external device to be coupled to such electronic equipment is not limited to a microcomputer but may be other types of equipment capable of data exchange.

CLAIMS

1. Electronic equipment with touch switches for exchanging data with an external device, comprising:

(a) a case of said electronic equipment;

(b) an electronic circuit which is arranged inside said case and which has at least one memory circuit and a control circuit for controlling said memory circuit;

(c) touch switch means arranged on the other surface of said case which is electrically coupled to said electronic circuit, said touch switch means serving as the input switches for controlling said electronic circuit when it is in contact with a human body, and in which the positions of said switches correspond to the positions of the connecting terminals for exchanging data with said external device; and

(d) writing means for supplying data in said memory circuit to said touch switch means in order to write the data from said touch switch means in said memory circuit so as to exchange the data with said external device.

2. The equipment according to claim 1, wherein said touch switch means has a plurality of touch electrodes which have the positions respectively corresponding to the positions of said connecting terminals to exchange the data of said external device.

3. The equipment according to claim 1, wherein said electronic circuit has a calculation function, and said touch switch means is a calculation data entry and function switch.

4. The equipment according to claim 1, wherein said electronic circuit has a clock function with a memory storing time data.

5. The equipment according to claim 1, wherein said equipment is a wrist watch.

6. The equipment according to claim 1, further comprising display means for displaying the data in said memory circuit which is supplied through said touch switch means.

7. The equipment according to claim 6, wherein said touch switch means is arranged above said display means.

8. Electronic equipment with touch switches for storing data supplied from an external device in a memory circuit, comprising:

(a) a case of said electronic equipment;

(b) an electronic circuit which is arranged inside said case and which has at least said

memory circuit and a control circuit for controlling said memory circuit;

(c) touch switch means arranged on the outer surface of said case which is electrically coupled to said electronic circuit, said touch switch means serving as the input switches for controlling said electronic circuit when it is contact with a human body, and in which the positions of said switches correspond to the positions of the data transmitting terminals of said external device; and

(d) writing means for writing the data from said external device in said memory circuit through said touch switch means so as to receive the data from said memory circuit.

9. The equipment according to claim 8, wherein said touch switch means has a plurality of touch electrodes which has a position corresponding to the position of said data transmitting terminals of said external device.

10. The equipment according to claim 8, wherein said electronic circuit has a calculation function, and said touch switch means is a calculation data entry and function switch.

11. The equipment according to claim 8, wherein said electronic circuit has a clock function with a memory storing time data.

12. The equipment according to claim 8, wherein said equipment is a wrist watch.

13. The equipment according to claim 8, further comprising display means for displaying the data in said memory circuit which is supplied through said touch switch means.

14. The equipment according to claim 13, wherein said touch switch means is arranged above said display means.

15. Electronic equipment with touch switches for supplying data stored in a memory circuit to an external device, comprising:

(a) a case of said electronic equipment;

(b) an electronic circuit which is arranged inside said case and which has at least said memory circuit and a control circuit for controlling said memory circuit;

(c) touch switch means arranged on the outer surface of said case which is electrically coupled to said electronic circuit, said touch switch means serving as the input switches for controlling said electronic circuit when it is in contact with a human body, and in which the positions of said switches corresponding to the positions of the data receiving terminals of said external device; and

(d) writing means for supplying the data from said memory circuit through said touch switch means to said external device.

16. The equipment according to claim 15, wherein said touch switch means has a plurality of touch electrodes which has a position corresponding to the position of said data receiving terminals of said external device.

17. The equipment according to claim 15, wherein said electronic circuit has a calculation function, and said touch switch means is a calculation data entry and function switch.

18. The equipment according to claim 15, wherein said electronic circuit has a clock function with a memory storing time data.

19. The equipment according to claim 15, wherein said equipment is a wrist watch.

20. The equipment according to claim 15, further comprising display means for displaying the data in said memory circuit which is supplied through said touch switch means.

21. The equipment according to claim 20, wherein said touch switch means is arranged above said display means.

22. The equipment according to claim 15, wherein said external device has memory means, and data stored in said memory means is written in said memory circuit through said touch switch means.

23. The equipment according to claim 15, wherein said external device has a key input section for data input.

24. The equipment according to claim 8, wherein said external device has memory means, and data stored in said memory means is written in said memory circuit through said touch switch means.

25. The equipment according to claim 8, wherein said external device has a key input section for data input.

26. An electronic equipment with touch switches, substantially as hereinbefore described with reference to the accompanying drawings.

Printed in the United Kingdom for Her Majesty's Stationery Office, Demand No. 8818935, 10/1984. Contractor's Code No. 6378.
Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.